REMARKS

The above-noted cancellation of claims 1-14, and addition of new claims 15-28, as well as the submission of a revised Abstract and revisions to the Specification, are respectfully submitted prior to initiation of the prosecution of this application in the U.S. Patent and Trademark Office.

The above-noted new claims are respectfully submitted in order to more clearly and appropriately claim the subject matter which applicant considers to constitute his inventive contribution. No new matter is included in these amendments. In addition, the revisions to the Abstract and Specification are submitted in order to clarify and correct the Abstract and Specification and to conform them to all of the requirements of U.S. practice. No new matter is included in these amendments.

In view of the above, it is respectfully requested that these amendments now be entered, and that prosecution on the merits of this application now be initiated. If, however, for any reason the Examiner does not believe such action can be taken, it is respectfully requested that he telephone applicant's attorney at (908) 654-5000 in order to overcome any objections which he may have.

If there are any additional charges in connection with this requested amendment, the Examiner is authorized to charge applicant's Deposit Account No. 12-1095 therefor.

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Respectfully submitted,

By _____

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METHOD AND APPARATUS FOR TRANSVERSE DISTRIBUTION OF A FLOWING MEDIUM

FIELD OF THE INVENTION

[0001] The present invention relates to a method and ~~an~~ apparatus for achieving even transverse distribution and propagation of a flowing medium.

BACKGROUND OF THE INVENTION

[0002] ~~For instance in~~ In the cellulose and paper ~~industry~~ industries, for example, it is necessary to be able to form webs of ~~fibre~~ fiber suspensions in an even and wide distributed flow in the transverse and longitudinal directions on a base, such as a roll, drum or the ~~similar~~ like. An uneven formation may ~~give a~~ thus result in an impaired pulp quality, for example due to ~~fibre~~ fiber damages at subsequent press nips in thicker formed sections, ~~canalisation~~ canalization of the washing liquid, and poor efficiency ~~at~~ during displacement washing.

[0003] Distribution of the flow of ~~mediums~~ the flowing medium is controlled substantially by frictional losses (i.e. pressure drop) when the medium flows through a distributor. In order to ensure an even distribution, propagation and discharge of the medium in the transverse direction along a long and narrow gap, e.g. ~~at~~ in a rectangular shaped distribution section, which is often desired, any of the following two principles mentioned ~~below~~ can be applied:

[0004] Design the distributor such that the pressure drop along each streamline, for an evenly distributed outlet flow, from the inlet to the outlet, become essentially the same.

[0005] Provide a large pressure drop at the outlet of the distributor such that the differences in friction losses along different streamlines become negligible compared to the outlet friction losses.

[0006] One problem ~~by~~ in applying the first principle (1) above is that the variation in velocity along individual streamlines of the flowing medium ~~flow~~ is hard to predict. This fact in combination with ~~the~~ limited knowledge about the boundary layer ~~behaviour~~ behavior of e.g. suspensions of wood ~~fibres~~ fibers, makes it difficult to predict the pressure drop along the streamlines. One problem is clogging of the distributor when the ~~fibres tends~~ fibers tend to slow down or adhere to the inner faces of the distributor which influences the runnability. Known distributors have also been shown to be sensitive ~~for~~ to variations in the flow velocity.

[0007] ~~The~~ One object of the present invention ~~aims~~ is to provide a method and an apparatus according to the first principle, where an improved propagation and distribution of a flowing medium is accomplished and where the above mentioned problems are ~~minimised~~ minimized.

SUMMARY OF THE INVENTION

[0008] This and other objects of the present invention have now been realized by the discovery of a method for obtaining an even transverse distribution and propagation of a flowing medium supplied through a conduit, the method comprising deflecting the flowing medium during diverging propagation of the flowing medium along at least one distribution gap having a frictional surface and a first depth, and conveying the flowing medium from the at least one distribution gap to an outlet gap having a second depth, the second depth being greater than the first depth, through a passage having an edge extending substantially transverse to the direction of flow of the flowing medium, the edge being shaped such that the propagation of the flowing medium as it flows within the distribution gap provides a substantially even and parallel flow of the flowing medium along the outlet gap. In a preferred embodiment, the method includes deflecting the

flowing medium by diverging propagation along a plurality of the distribution gaps, each of the plurality of distribution gaps having a different depth. Preferably, the plurality of distribution gaps has a depth in the range of 8 to 60 mm.

[0009] In accordance with one embodiment of the method of the present invention, the second depth is from 1.2 to 4 times the first depth.

[0010] In accordance with another embodiment of the method of the present invention, the at least one distribution gap includes at least two diverging frictional surfaces interconnected by an edge shaped in the form of a circular arc.

[0011] In accordance with another embodiment of the method of the present invention, the method includes conveying the flowing medium so as to propagate the flowing medium in a rectangular cross-sectional shape. In accordance with another embodiment of the method of the present invention, the method includes redirecting the conveying of the flowing medium in at least one curved section.

[0012] In accordance with the present invention, the above and other objects have also been realized by the discovery of a distributor for the even transverse distribution and propagation of a flowing medium comprising a distribution housing including a supply conduit for supply of the flowing medium and at least one distribution gap having a frictional surface and a first depth for deflecting the flowing medium during the propagation, the distribution gap having a diverging shape for propagation of the flowing medium, and an outlet gap having a second depth for passage of the flowing medium after passage through the distribution gap, the second depth being greater than the first depth, and the distribution housing further comprising a passage between the distribution gap and the outlet gap, the passage comprising an edge

extending substantially transverse to the direction of flow of the flowing medium, the edge being shaped such that the propagation of the flowing medium as it flows within the distribution gap provides a substantially even and parallel flow of the flowing medium along the outlet gap. In a preferred embodiment, the distributor comprises a plurality of the distribution gaps, each of the plurality of distribution gaps having a different depth.

[0013] In accordance with one embodiment of the distributor of the present invention, the plurality of distribution gaps has a depth in the range of 8 to 60 mm.

[0014] In accordance with another embodiment of the distributor of the present invention, the second depth is from 1.2 to 4 times the first depth.

[0015] In accordance with another embodiment of the distributor of the present invention, the at least one distribution gap has a substantially rectangular cross-sectional shape.

[0016] In accordance with another embodiment of the distributor of the present invention, the at least one distribution gap comprises at least two diverging frictional surfaces interconnected by an edge in the shape of a circular arc.

[0017] In accordance with another embodiment of the distributor of the present invention, the distributor includes at least one curved section for redirecting the flow of the flowing medium from the supply conduit to the outlet gap.

[0018] ~~This object is~~ The objects of the present invention are achieved by a method for obtaining even transverse distribution and propagation of a flowing medium ~~according to the present invention,~~ where: the medium is supplied through a conduit and is deflected during propagation in at least one distribution gap defined by a frictional surface; the medium

is deflected during diverging propagation along the distribution gap; the medium is conveyed from the distribution gap ~~via~~ through a passage to an outlet gap having a larger column depth than the depth of the distribution gap; the medium is conveyed over an edge, that constitutes a passage to the outlet gap, extending substantially transverse to the direction of ~~the~~ flow; and the edge is shaped such that the frictional surface obtains ~~a~~ propagation along the flowing path of the diverging medium in the distribution gap that provides a substantially even and parallel flow of the flowing medium along the outlet gap.

[0019] In that respect, ~~it is accomplished that~~ frictional losses, in accordance with the present invention, for an evenly distributed outlet flow, ~~becomes~~ become essentially similar for all streamlines. The shape of the edge is intended to vary the quantity of frictional surface along different streamlines in the distribution gap, in order ~~by that way~~ to therefore provide an evenly distributed flow out of the outlet gap. Owing to the increase of the cross-section of the outlet gap ~~at~~ during passage of the edge that extends substantially in the transverse direction, the pressure drop per unit of length along a streamline decreases, which causes the shaping of the outlet gap to become of reduced significance, in relation to other parts of the apparatus.

[0020] By "medium" in this description is meant liquids, gases, foam, ~~fibre~~ fiber suspensions or other mixture of substances.

[0021] After passage ~~via~~ through the gaps, the flowing medium passes an outlet opening. Preferably, the outlet opening is preceded by several distribution gaps having different column depths for the purpose ~~to~~ of controlling frictional losses in different parts of the machine.

[0022] An outlet gap may suitably have a column depth at the outlet opening that is in the size of 1.2- to 4 times the column depth of the preceding gap.

[0023] By "frictional surface" in this description is meant those surfaces with which the flowing medium is in contact. It is the quantity of frictional surface in the distribution gap, alternatively the distribution gaps, and not the outlet gap, that controls the profile of the flow. The shape of the edge may compensate for frictional losses in the outlet gap.

[0024] ~~The~~ In accordance with the present invention, ~~also relates to~~ a distributor has been discovered for the even transverse distribution and propagation of a flowing medium. The distributor comprises a distribution housing with a conduit for supply of the medium and deflection during propagation in at least one distribution gap arranged in the distributor defined by a frictional surface. The distribution housing comprises an outlet opening ~~via~~ through which the medium ~~is passing~~ passes after its passage through the distributor. The distribution gap is shaped with a diverging propagation. The distribution housing comprises a passage between the distribution gap and an outlet gap which is arranged with a larger column depth than the depth of the distribution gap. The passage comprises an edge, extending substantially transverse to the direction of ~~the~~ flow, ~~that~~ and which constitutes a passage to the outlet gap~~,~~. The edge is shaped such that the frictional surface obtains a propagation along the flowing path of the diverging medium in the distribution gap that provides a substantially even and parallel flow of the flowing medium along the outlet gap.

~~Additional features according to embodiments of the method and the apparatus according to the present invention is evident from the claims.~~

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The present invention will now be described in more ~~in~~ detail ~~by examples of application, by reference~~ with reference to the following detailed description, which in turn refers to the accompanying drawings, without limiting the interpretation of the invention thereto, where

[0026] ~~fig~~Fig. 1A ~~schematically in a perspective~~ is a perspective, schematic, top view ~~shows~~ of a distributor according to an embodiment of the present invention~~,~~;

[0027] ~~fig~~Fig. 1B ~~shows a cross-section A-A~~ is a side, elevational, cross-sectional view taken along section A-A of the distributor shown in ~~fig~~ Fig. 1A~~,~~;

[0028] ~~fig~~Fig.. 2A~~-D~~ ~~shows schematically in a~~ is a top, elevational, partially schematic view ~~straight from above different embodiments~~ of an edge of the distributor according to the present invention, ~~and~~ showing the effect on the flow distribution out of the distributor~~,~~;

[0029] Fig. 2B is a top, elevational, partially schematic view of an edge of another distributor according to the present invention, showing the effect on the flow distribution out of the distributor;

[0030] Fig. 2C is a top, elevational, partially schematic view of an edge of another distributor according to the present invention, showing the effect of the flow distribution out of the distributor;

[0031] Fig. 2D is a top, elevational, partially schematic view of an edge of another distributor according to the present invention, showing the effect on the flow distribution out of the distributor;

[0032] ~~fig~~Fig. 3 ~~schematically shows in a~~ is a top, elevational, partially schematic view ~~straight from above~~ of another embodiment of a distributor according to the present invention~~,~~;

[0033] ~~fig~~Fig. 4A ~~shows schematically in a~~ is a side, perspective view of yet ~~an~~ another embodiment of a distributor according to the present invention~~,~~;

[0034] ~~fig~~Fig. 4B ~~shows a cross-section A-A~~ is a side, elevational, cross-sectional view taken along section A-A of the distributor shown in ~~fig~~ Fig. 4A~~,~~; and

[0035] ~~fig~~Fig. 5 ~~shows schematically in a~~ is a top, elevational, partially schematic view ~~straight from above yet an~~ of yet another embodiment of a distributor according to the present invention.

DETAILED DESCRIPTION

[0036] ~~In figs~~Turning to the figures, Figs. 1A and 1B ~~are shown~~ show a distributor according to an embodiment of the present invention for even, transverse distribution and propagation of a flowing medium. The distributor comprises a distribution housing 2 with a conduit 4 for supply of the medium and a wide outlet opening 6.~~, the~~ The distribution housing is shaped with a distribution chamber 8 and an outlet chamber 10, which chambers are formed by limiting surfaces 12, whose inner faces are denoted as frictional surfaces. The supply conduit 4 in fig.1 is arranged at an angle to the distribution chamber 8, but may also be arranged in parallel to the direction of the flow S. The distribution chamber 8 has a distribution gap 14 that extends from the connection of the conduit in a diverging, conical propagation to a passage 16 having an edge 18, extending substantially transverse to the direction of the flow, with a radius of curvature R, which edge 18 e.g. has the shape of an arc, at which passage 16 the outlet chamber 10 is connected. The distribution gap 14 of the distribution chamber communicates ~~via~~ through the passage 16 with an outlet gap 20 of the outlet chamber, which outlet chamber 20 is arranged with a larger column depth than the depth of the distribution gap 14 of the distribution housing

2, which outlet gap 20 extends from the passage 16 to the rectangular outlet opening 6. Both gaps, 14~~,~~ and 20, have a substantially rectangular cross-section. The pressure drop along each streamline, from the supply ~~via said~~ through the conduit 4 to a discharge of the output flow of the medium ~~via~~ through the outlet opening 6, for an evenly distributed outlet flow, is essentially the same, providing a substantially even and parallel outlet flow.

[0037] Since the distance along each streamline is not equal in the outlet chamber 10, the pressure drop in this chamber shall be relatively small in comparison to the pressure drop in other parts of the apparatus.

[0038] The supply conduit 4 can be arranged in the vicinity of the intersecting line C for the diverging, limiting surfaces. Preferably, the distribution chamber 8, from the inlet forward to the edge extending essentially in the transverse direction, is provided with two diverging limiting surfaces, ~~and~~ which ~~preferably~~ are preferably interconnected by an edge 18 shaped as a circular arc.

[0039] According to ~~an~~ one embodiment of the present invention, the passage between the distribution channel 8 and the outlet chamber 10 can be provided with sections of a plurality of distribution gaps, having different column depths, which is described more closely below with reference to ~~fig~~ Fig. 5. Thus, the number of gaps with different column depths can be more than two, suitably three or four, and the passage between two or a plurality of gaps may be provided by an edge shaped in a similar way as the edge 18 described herein. The distribution gaps may have increasing column depths along the direction of the flow. However, according to a preferred embodiment, the distributor according to the present invention comprises alternating increasing and decreasing column depths of the distribution gaps.

[0040] The purpose of arranging a plurality of gaps is to be able to control frictional losses in different parts of the machine. The gaps may have a column depth in the range of 8 to 60 mm.

[0041] An outlet gap at the outlet opening 6 can have a column depth (h_2) that is in the size of 1.2- to 4 times the column depth (h_1) of the preceding gap, ~~suitably~~ and preferably 1.5- to 4 times the column depth (h_1) of the preceding gap.

[0042] The same reference numerals are used in the drawings to the extent that details in the different embodiments are in correspondence.

[0043] Figs. 2A-D ~~shows~~ show variations of the shape of the edge 18 and ~~where it is illustrated~~ illustrate how the flow picture is altered when changing the curvature of an arc-formed edge.

[0044] According to ~~an~~ one embodiment, the edge 18 may have a substantially circular arc-formed extension with a radius of curvature R, which radius may have a different curvature for different embodiments of distributors, such as for example is shown in ~~fig~~ Figs. 2A-C. The supply conduit 4 can be arranged in a ~~centre~~ center on a chord of the circular arc. Preferably, the distributor chamber 8, from the inlet forward to the circular arc of the apparatus, is substantially cone-shaped. This section may form a sector of a circle. Fig. 2C shows an embodiment of the circular arc where all ~~radius~~ radii R of the sector of the circle converge in one central point C (see also ~~fig~~ Fig. 1A). In this way it is also ensured that the path each streamline follows from the inlet forward to the circular arc is equally long. Then the supply conduit 4 is placed in the central point C. The radius of curvature R of the circular arc may be larger than what is shown in ~~fig~~ Fig. 2C, such as is evident from ~~fig~~ Figs. 2A and 2B. ~~On basis from that a shaping~~ A shape according to ~~fig~~ Fig. 2B is assumed to produce

an evenly distributed flow V along the ~~whole~~ entire outlet opening 6, there will be a change to a shallower circular arc, i.e. having a larger radius of curvature R_1 than the ~~shaping~~ shape of the edge with the radius of curvature R_2 in ~~fig~~ Fig. 2B, resulting in a larger flow V_1 in the middle of the outlet opening and a smaller flow V_2 against the side edges 12' of the outlet opening, in comparison to ~~fig~~ that of Fig. 2B. If, instead, in comparison with ~~fig~~ Fig. 2B, a deeper circular arc is provided, i.e. one having a smaller radius of curvature R than the ~~shaping~~ shape of the edge having the radius of curvature R_2 in ~~fig~~ Fig. 2B, this results in a lower flow V_2 in the middle of the outlet opening and a larger flow V_1 at the side edges 12' of the outlet opening in comparison to the shaping according to ~~fig~~ Fig. 2B.

[0045] In ~~fig~~ Fig. 2D is shown an embodiment of another shape of the edge 18, ~~here~~ in this case made of two essentially straight edge sections, 22, and 24, that ~~are met in~~ meet at a point near the middle of the outlet opening 6. The edge sections, 22, and 24, form an angle α between them. The flow picture for the ~~shown~~ embodiment ~~of fig~~ shown in Fig. 2D is similar to ~~fig~~ that of Fig. 2C, i.e. the flow V_1 is largest at the side edges 12' of the outlet opening and lower V_2 in the middle of the outlet opening in comparison to the shaping according to ~~fig~~ Fig. 2B. The edge may also be provided with other angles between the straight sections of the edges, 22, and 24, depending on which flow picture ~~that~~ is desired along the outlet opening. The edge 18 may also be provided with more than two edge sections (not shown).

[0046] In ~~fig~~ Fig. 3 is shown ~~an~~ another embodiment according to the present invention. By an essentially circular arc-formed edge 18 it is meant that sections of the edge 18 may have ~~a~~ differing ~~shaping~~ shapes, but that the passage between the distribution gap 14 and the outlet gap 20 mainly

follows the shape of a circular arc. For instance, the circular arc may terminate against the respective side edges 12′ of the apparatus ~~terminate~~ with straight sections 22, which sections substantially extends parallel with the side edges 12′ of the outlet chamber. The circular arc may thus be shortened against the side edges 12′ in order to compensate for increasing frictional losses at the edges 12′.

[0047] According to the present invention, the flow ~~is moving~~ moves through a channel extending substantially in ~~the~~ a plane. For that reason, redirection of the flow is ~~minimised~~ minimized, whereby problems with clogging can be ~~minimised~~ minimized. According to yet one embodiment according to the present invention, as evident from ~~fig~~ Figs. 4A-B, the apparatus may nevertheless comprise at least one redirection 24, such as a curved section or the ~~similar~~ like. The pressure drop in consequence of the redirection is negligible. This design can be preferred for technical assembly reasons.

[0048] ~~In fig~~ Fig. 5 ~~is shown~~ shows a preferred embodiment according to the present invention, where the distributor comprises a first distribution gap 14′, a second distribution gap 14′′, a third distribution gap 14′′′ and an outlet gap 20. The first distribution gap 14′ is arranged from the inlet forward to a first circular arc-shaped edge 18′ that interconnects two diverging limiting surfaces that constitutes a first distribution chamber 8′. The second distribution gap 14′′ is arranged from the first circular arc-shaped edge 18′ forward to a second circular arc-shaped edge 18′′ that interconnects two diverging limiting surfaces that constitutes a second distribution chamber 8′′. The third distribution gap 14′′′ is arranged from the second circular arc-shaped edge 18′′ forward to an edge 18′′′ extending essentially linearly in the transverse direction, that interconnects two substantially diverging limiting surfaces that constitutes a

third distribution chamber 8''''. The edge extending in the transverse direction constitutes the passage to the outlet gap 20. Sections of the side edges 12'' of the gaps 14', 14'', 14''' and 20 are angled in the broken points P at the second distribution gap 14'' and at the third distribution gap 14''''. The second distribution gap 14'' preferably has a lower column depth than the first distribution gap 14'. The third distribution gap 14''' preferably has an equal column depth as the first distribution gap 14'. The outlet gap 20 has preferably a larger column depth than the third distribution gap 14''''.

[0049] With reference now to the ~~figs~~ Figs. 1-5, a ~~fibre~~ fiber suspension having a concentration of e.g. up to 12% may thus be supplied to the distribution housing 2 ~~via~~ through the supply conduit 4. The ~~fibre~~ fiber suspension that enters the distribution chamber, 8, 8', hits the inner limiting surfaces 12 of the housing and is thereby deflected. The suspension is spread from the inlet by decreasing speed outwardly in the distribution gap, 14, 14', in the diverging distribution chamber, 8, 8', to the passage 16 where it once more is deflected when it passes the edge, 18, 18', of a preferred circular arc-shape and passes into the outlet gap 20 having a larger column depth, alternatively passes into yet ~~one~~ another distribution gap 14'' having a preferred lower column depth and thereafter a distribution gap having a higher column depth than the preceding gap before the outlet gap 20 as described with reference to ~~fig~~ Fig. 5. After the suspension has been conveyed into the outlet chamber 10, the suspension is forced against the outlet opening 6 to flow in an even substantial parallel flow with a constant velocity.

[0050] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of

the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

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~~Abstract~~

ABSTRACT OF THE DISCLOSURE

~~The present invention relates to a method~~ Methods for achieving even transverse distribution and propagation of a flowing medium are disclosed in which the ~~. The~~ flowing medium is supplied through a conduit ~~(4)~~ and is deflected during diverging propagation in at least one distribution gap ~~(14, 14', 14'', 14''') defined by a friction surface~~. The method includes deflecting the flowing medium ~~is deflected~~ during diverging propagation along the distribution gap ~~(14, 14', 14'', 14''')~~; ~~The~~ in which the medium is conveyed ~~via~~ through a passage ~~(16)~~ to an outlet gap ~~(20)~~ having a larger ~~gap~~ depth than the depth of the distribution gap~~,~~. The medium is conveyed over an edge ~~(18, 18', 18'', 18''')~~ of the passage extending transverse to the direction of the flow, and the edge ~~(18, 18', 18'', 18''')~~ is designed ~~such that the friction surface~~ to obtain a propagation along the flowing path of the diverging medium that provides a substantially even and parallel flow of the medium along the outlet gap ~~(20)~~. ~~The present invention also relates to an apparatus.~~ Apparatus for achieving this method is also disclosed.